Final Report

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Prince William Sound Oil Spill Recovery Institute

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Name of awardee/grantee: Prince William Sound Science Center

OSRI contract number: 09-10-14

Project title: Field Support for 2009 Sound Predictions

Dates project began and ended: April 1, 2009 to December 31, 2009

1 Project summary/abstract

The intent of this project was to augment the current sampling efforts planned in the AOOS/OSRI Sound Predictions 2009 model validation field experiment in Prince William Sound (`www.aoos.org/fieldexp/`). In particular, it was intended to provide information on the circulation below the mixed layer in Prince William Sound (PWS) and to ensure that all three vessels participating in the experiment had newly-calibrated Conductivity-Temperature-Depth (CTD) sensors.

2 Objectives

The first objective was to quantify circulation below the mixed layer. To do so, three SVP style drifters with drogues centered at 40m were purchased from Pacific Gyre Inc. The drifters recorded GPS position at 10 minute intervals and transmitted via the Iridium satellite network.

Secondly, in order to maximize the amount of hydrographic data obtained during the field experiment, it was desirable to ensure each of the three vessels carried a CTD. One recently calibrated PWSSC CTD was set aside for the main hydrographic boat. A second PWSSC CTD, as well as another acquired on loan from the NOAA Kasitsna Bay lab, were sent to the manufacturer for diagnostics and calibration. The calibration ensured that each instrument provided the highest quality data.

3 Results

Raw data was archived at Pacific Gyre, Inc. Initial processing was performed by Dr. Carter Ohlmann at the University of California Santa Barbara. The processed data was then used to update a real-time display in Google Earth during the experiment. The data was sent to AOOS for archival and distribution purposes and then to the Jet Propulsion Laboratory for ingestion into a circulation model of PWS. In preparation for publications, post-experiment processing has been completed by Mark Halverson, the Prince William Sound Science Center (PWSSC) oceanographer.

All three 40m drifters were deployed as a group in the central basin on two separate occasions during the experiment. The trajectories of each deployment are shown in Figs. 1 and 2. During the first deployment, which lasted from July 20 until July 26, 2009, the drifters maintained a westward course with a small component to the north and then later to the south. During the second deployment, from July 26 until August 3, the drifters completed a closed circuit in a counter-clockwise direction.

The winds measured at buoy 46060 in mid-sound differed during these two periods as is shown by the small inset axes in Figs. 1 and 2. They began as consistent southeasterlies ranging in speed from 10 to 15 m/s. During the second deployment, the winds started with southeasterlies for a few days before giving way to southerlies and eventually westerlies.

The timing of the change in drifter trajectories and the change in wind strength and direction might suggest a direct link. However, details of how wind could affect

circulation at 40m, which is well below the mixed layer, are unclear. While purely speculative at this point in the analysis, it is conceivable that the wind could set up sea surface height gradients which in turn would then redistribute the isopycnals.

The distribution of water properties as measured by the CTDs provides a way to track water masses in PWS, and a way to estimate the component of the total flow driven by pressure gradients. As an example, consider two salinity sections taken from a subset of all the stations sampled during the field experiment shown in Fig. 3. A salinity transect from the North/South line (Fig. 4) reveals that the perimeter of the central basin contains more fresh water in the top 50m than in the center. Likewise, an East/West transect shows a similar pattern (Fig. 5). The geostrophic flow implied by this distribution would tend to form a recirculating cyclonic gyre (in the absence of strong winds).

4 Conclusions

The additional information gained from this project has contributed a significant amount of information to the Sound Predictions 2009 field project. The circulation in the main basin below the mixed layer has been quantified with 40m drifters. The drifters revealed two different circulation patterns, which coincide with a change in wind speed and direction. The two extra CTDs provided extra high quality hydrographic data.

A Presentation abstracts

EPOC 2009 - September 2009 - Sidney, B.C.

Upper water column circulation of Prince William Sound from drifting buoys during the Sound Predictions 2009 Field Experiment

The Sound Predictions 2009 field experiment was designed to quantitatively evaluate the performance of forecast models in Prince William Sound, Alaska. These include the WRF atmospheric and ROMS ocean circulation models, the SWAN wave model, the CoSINE NPZ ecosystem model, the NOAA GNOME search and rescue trajectory model, and the Alyeska ATOM trajectory model. Field data for model validation and assimilation was collected over a span of 15 days in late July 2009. During this time, three vessels amassed oceanographic data from more than 40 drifting buoys, three CTDs, two HF radar sites, one glider, one AUV, one underway thermosalinograph, and three near-shore moorings.

In this talk, we present preliminary results from the drifter deployments. In total, there were five different drifter styles, sampling four different depths: surface, 1-m, 10-m, and 40-m. The deployments span a wide range of wind and wave conditions. Most tracks confirm the presence of an cyclonic gyre in the central region of Prince William Sound. Hydrographic transects and CODAR surface current maps support this observation. Deviations from the gyre pattern are caused by tides and wind, and the magnitude of the deviation depends on the depth sampled by the buoy. Further analysis may include comparing the performance of different drogue types (for the 1-m), and quantifying basic fluid properties in a semi-enclosed coastal sea.

AMSS - January 2010 - Anchorage, AK

Upper water column circulation in Prince William Sound from drifting buoys

Abstracts were not required because the presentation was given as part of a special workshop on the Sound Prediction 2009 field experiment. The focus on the talk was on the upper water column hydrography and geostrophic flow and its relation to the drifter trajectories.

AGU OS - February 2010 - Portland, OR

Evolution of a cyclonic gyre in Prince William Sound, Alaska

Prince William Sound is a semi-enclosed coastal sea in the northern Gulf of Alaska that supports a significant commercial fishery and hosts the Trans Alaska Pipeline terminal. A predictive understanding of the ocean circulation is thus important for a variety of applied problems in fisheries and oil spill management. To this end, a coordinated observational and modeling program took place over a two-week period in late July to early August 2009. Oceanographic data collected during the field

experiment includes surface currents from high frequency (HF) radar and drifting buoys, and hydrographic data from a glider, a ROV and shipboard profiles.

Observationally-based descriptive and dynamical views of the upper ocean circulation and stratification in Prince William Sound during the summer field campaign are presented. In particular, we focus on the circulation in the central basin, where a closed-core cyclonic gyre formed midway through the experiment. Such a feature has been inferred in Prince William Sound in the past from maps of dynamic height, but its dynamics have not been described. The data from this study, however, permit a detailed look at how Ekman dynamics, tides, and pressure gradients contribute to its evolution. For example, periods of strong winds (>10 m/s) allow the interaction of Ekman dynamics with a region of varying relative vorticity to be investigated.

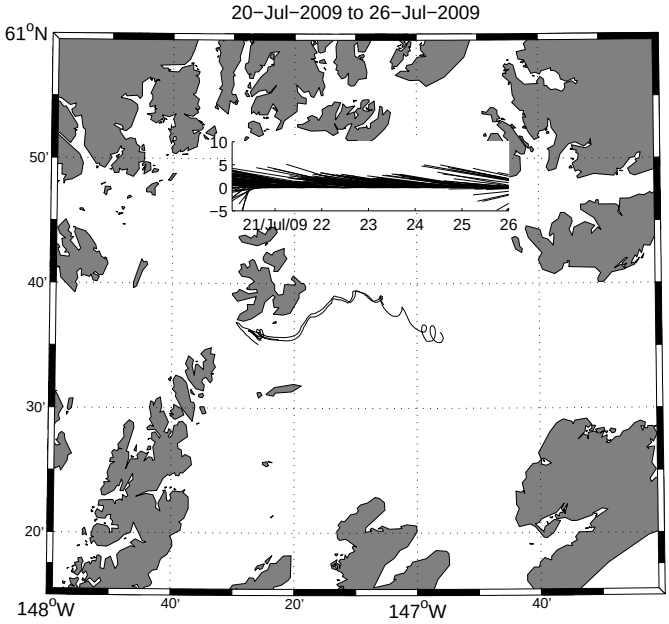

Figure 1: Trajectories for the first of the 40m deployments for the period 20 July to 26 July 2009. Three drifters were released in a tight cluster in the central basin (note one drifter did not transmit for the first few days). The inset axes shows the measured wind vectors.

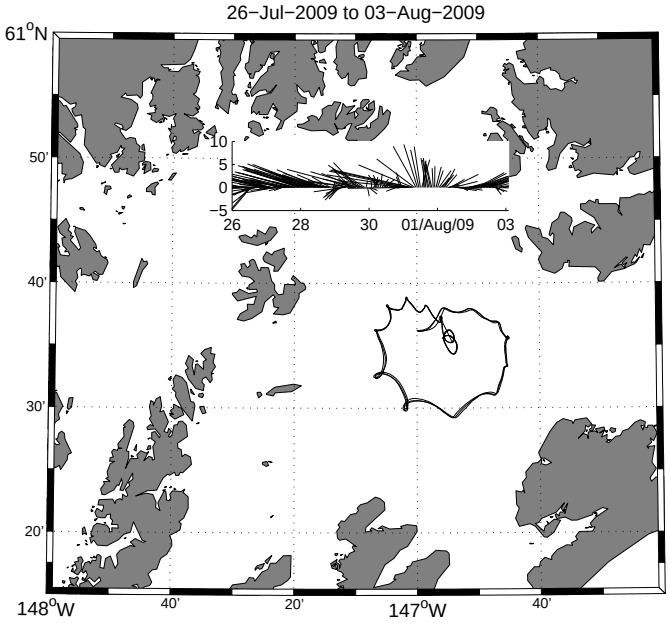

Figure 2: Same as for Fig. 1 except for the period 26 July to 3 August 2009. Note how the winds differ to those observed during the first deployment.

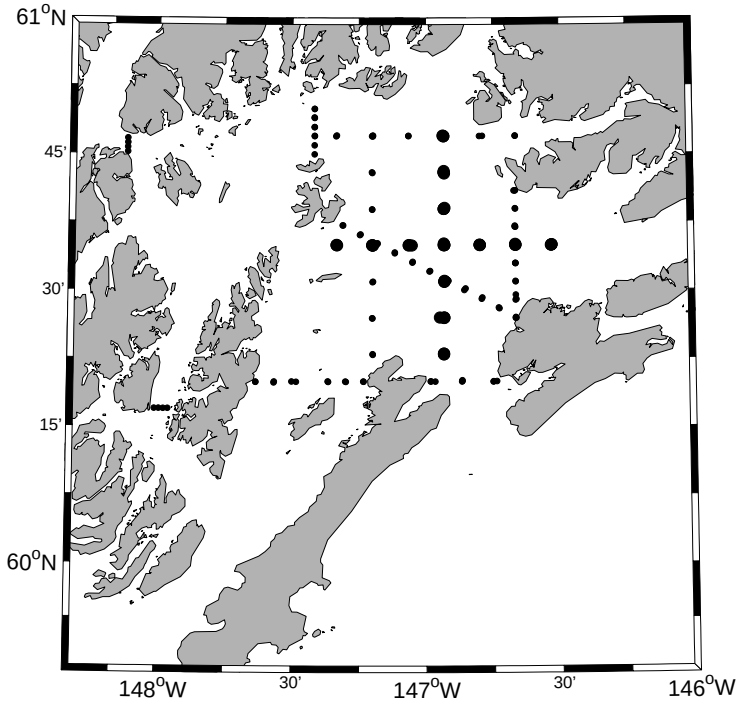

Figure 3: CTD stations sampled during the 2009 Sound Predictions experiment. The larger circles represent the main North/South and East/West transects.

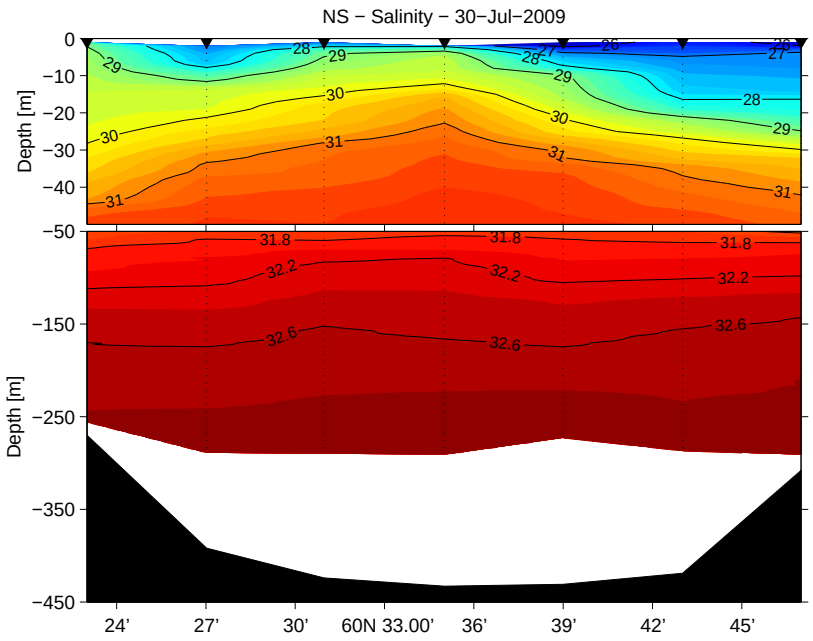

Figure 4: North/South transect of salinity across the main basin. Note the upper 50m of the water column has been expanded to emphasize the structure. The geostrophic flow implied by this distribution is westward in the north and eastward in the south.

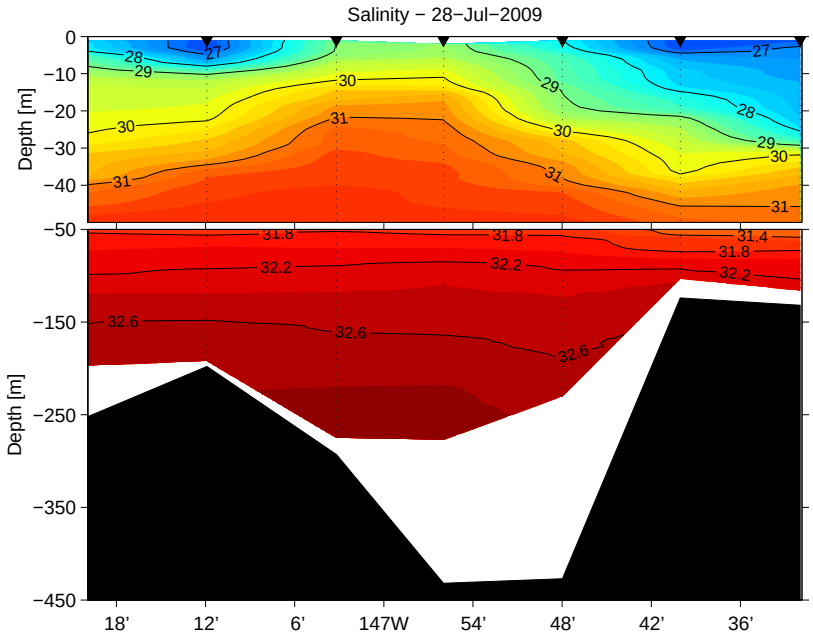

Figure 5: East/West transect of salinity across the main basin. Note the upper 50m of the water column has been expanded to emphasize the structure. The domed isohalines, which are also present in the North/South transects, suggest a cyclonic gyre in the central basin.